Global Nuclear Energy Partnership Technology Demonstration Program

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Global Nuclear Energy Partnership

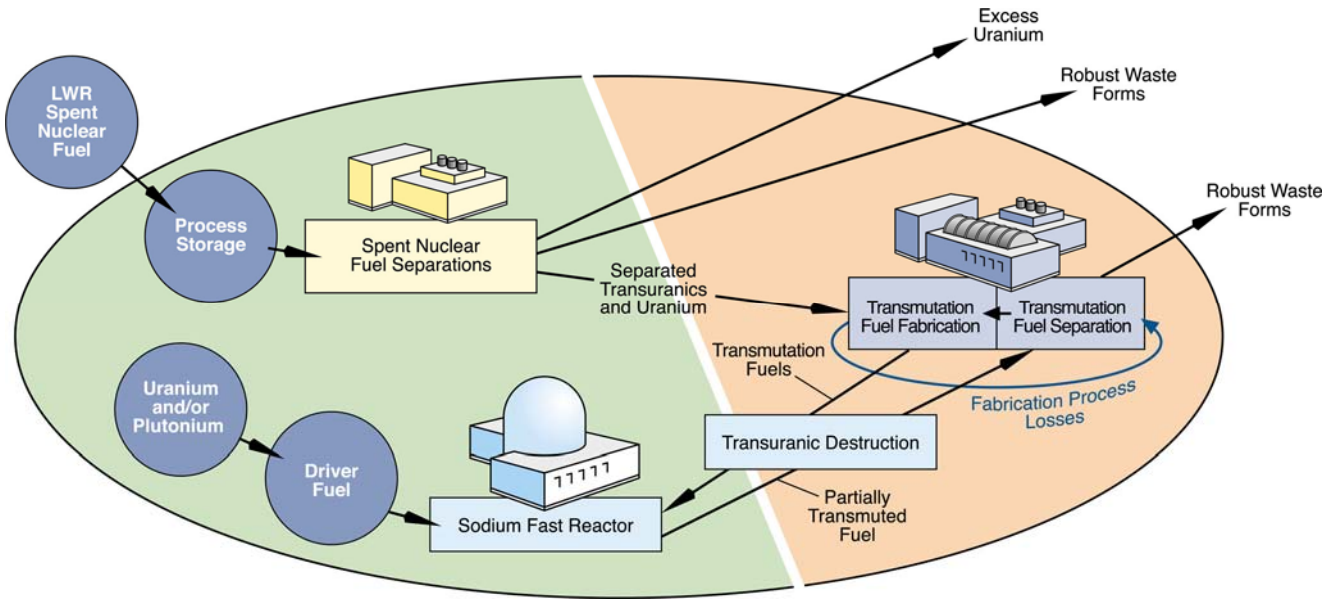
- Goals of GNEP:
  - Expand domestic use of nuclear power;
  - Demonstrate more proliferation-resistant recycling;
  - Minimize nuclear waste;
  - Develop advanced burner reactors;
  - Establish reliable fuel cycle services;
  - Demonstrate small-scale reactors;
  - Develop enhanced nuclear safeguards.

Global Nuclear Energy Partnership Technology Demonstration (GNEP-TD)

- GNEP Technology Demonstration Program
  - Focus on domestic demonstration of key technologies
  - International partnerships in technology development
  - Embedded university program
- 5-year technology plan under development
  - 9 labs involved
- Provision of intellectual basis for GNEP-TD decisions
  - Basis studies

- Office of Science is supporting nuclear technology through coordinated programs in BES (Chemistry, materials etc), Nuclear Physics and Comuptation

GNEP Technology Demonstration Facilities



GNEP-TD Facilities

- **Engineering-Scale Demonstration (ESD)**
  - Demonstration of the UREX+1a process
  - Source of supply of transuranic elements for Advanced Burner Test Reactor
  - Suitable for process optimization
  - Size is to be determined from performance requirements
- **Advanced Burner Test Reactor (ABTR)**
  - Demonstrate performance of transmutation fuel
  - Size is to be determined from performance requirements
- **Advanced Fuel Cycle Facility (AFCF)**
  - Modular research laboratory
    - *Aqueous separations demonstration at up to 25 metric tons per year*
    - *Pyrochemical separations demonstration at 1 metric ton per year*
    - *Recycle fuel fabrication development and demonstration*
    - *Supporting R&D laboratories*

GNEP Separations Technology Development

- Two main program paths
  - Management of the spent fuel generated by current generation LWRs and future ALWRs (ESD)
  - Closure of the fuel cycle for advanced burner reactors (AFCF)

- Near term objective is dealing with the large amount of spent fuel generated by the current fleet of commercial power reactors
  - Spent fuel generated at a rate of about 2,000 metric tons (heavy metal) per year
  - Projected accumulation of commercial spent fuel will greatly exceed the legislated capacity of the Yucca Mountain repository by 2050
  - Goal is to preclude or significantly delay the need for a second geologic repository

Advanced Aqueous Processing of LWR Spent Fuel

- Aqueous solvent extraction process is the reference method being developed for treatment of LWR spent fuel
  - High degree of technological maturity; industrial practice in France, the United Kingdom, Russia, and Japan
  - Capable of achieving high decontamination factors for separated products
    - *For thermal recycle, must eliminate high cross section fission products nearly completely (DF>10,000 required)*
    - *For fast reactor recycle, must reduce the rare earth content (DF>250 for separation of lanthanides from transuranics)*
  - Provides flexibility in degree of partitioning of radionuclides present in spent fuel
    - *Emphasis on group extraction of transuranics to confer a degree of proliferation resistance to the process*
    - *Suite of process variants under development*

Suite of UREX+ Processes

Process	Prod #1	Prod #2	Prod #3	Prod #4	Prod #5	Prod #6	Prod #7
UREX+1	U	Tc	Cs/Sr	TRU+Ln	FP		
UREX+1a	U	Tc	Cs/Sr	TRU	All FP		
UREX+2	U	Tc	Cs/Sr	Pu+Np	Am+Cm+Ln	FP	
UREX+3	U	Tc	Cs/Sr	Pu+Np	Am+Cm	All FP	
UREX+4	U	Tc	Cs/Sr	Pu+Np	Am	Cm	All FP

Notes: (1) in all cases, iodine is removed as an off-gas from the dissolution process.
(2) processes are designed for the generation of no liquid high-level wastes

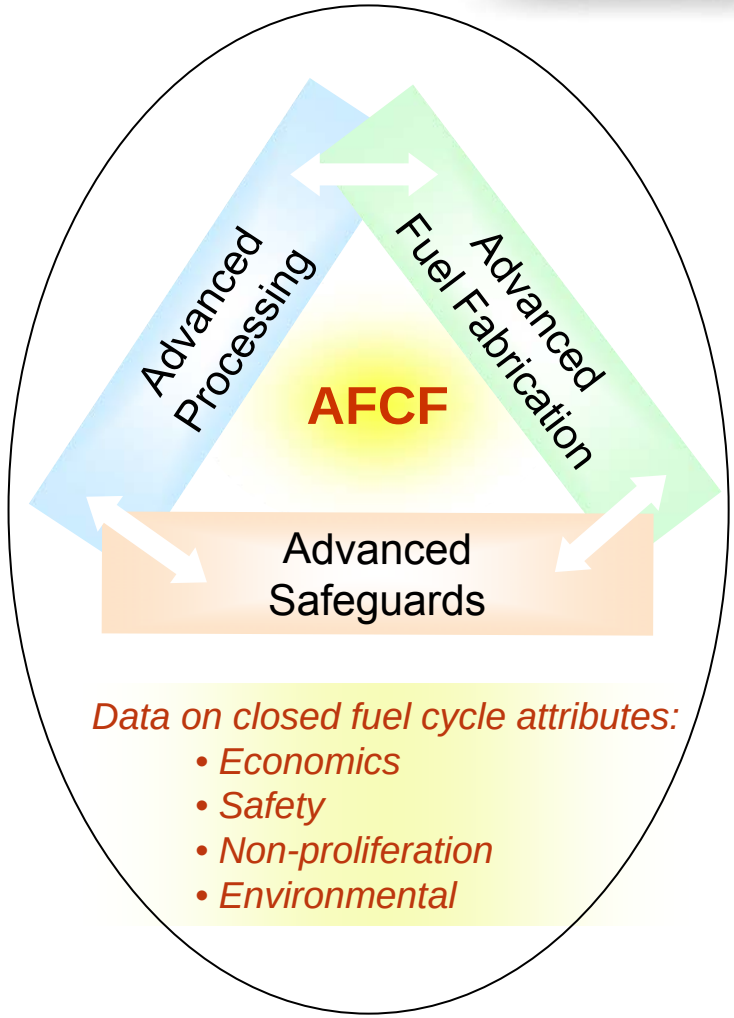
U: uranium (removed in order to reduce the mass and volume of high-level waste)
Tc: technetium (long-lived fission product, prime contributor to long-term dose at Yucca Mountain)
Cs/Sr: cesium and strontium (primary short-term heat generators; repository impact)
TRU: transuranic elements (Pu: plutonium, Np: neptunium, Am: americium, Cm: curium)
Ln: lanthanide (rare earth) fission products
FP: fission products other than cesium, strontium, technetium, iodine, and the lanthanides

Advanced Fuel Cycle Facility (AFCF) main mission is to develop and demonstrate advanced fuel recycling technologies

- Cost effective alternatives for high level nuclear waste management in the form of advanced closed fuel cycles.
- Advanced proliferation-resistant fuel recycling technologies including chemical processing and fuel fabrication.
- Advanced safeguards including advanced instrumentation for materials protection, control and accountability (MC&A), and advanced control and monitoring systems.

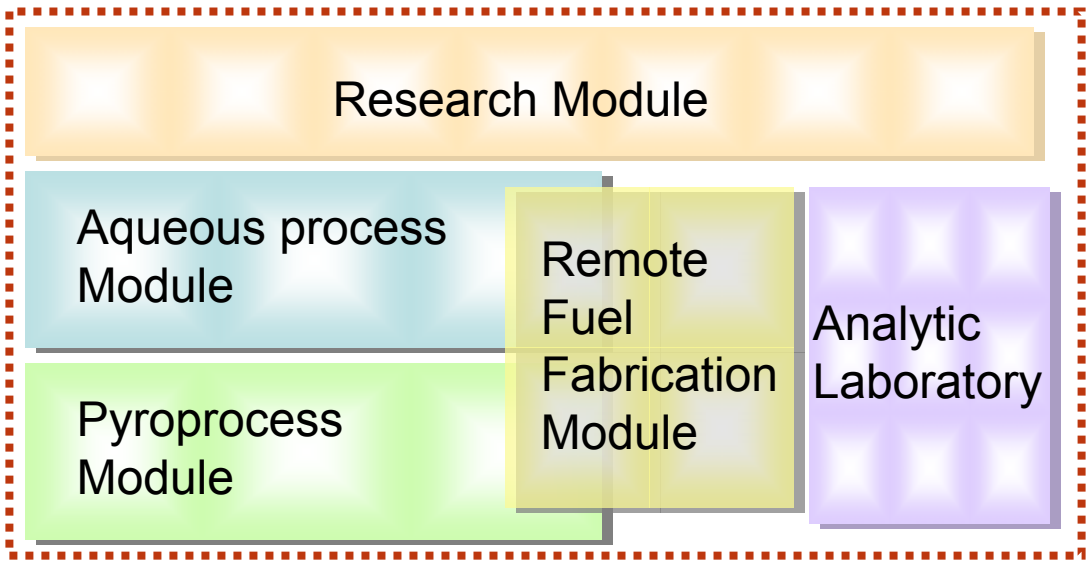
AFCF is a multi-purpose facility for bench-scale to engineering-scale technology development & demonstration

- Remote fuel fabrication development and demonstration. Fabrication of transuranic (TRU) -bearing transmutation fuels at the rod and subassembly scale.
- Integrated aqueous process development and demonstrations of spent fuel treatment using Light Water Reactor (LWR) spent nuclear fuel (SNF).
- Integrated dry process development and demonstration of fast reactor (FR) spent fuel treatment.
- Development and proof-testing of advanced safeguards instrumentation and methodology.
- Process improvements, either in the form of new flow-sheets or advanced process equipment.
- Flexibility to facilitate the development and demonstration of recycling methods for advanced fuel types that can support a number of fuel cycle strategies.



AFCF will contain multiple modules with hot-cells and shielded glove-boxes.

- Remote fuel fabrication module ≤ 8 LTA/yr
- Aqueous processing facility ≤ 25 ton/yr
- Pyroprocessing module ≤ 1 ton/yr
- R&D module: small-hot cells and shielded glove-boxes for bench-scale research.



Advanced Burner Test Reactor: A Key Component of GNEP-TD

- Thermal reactors only suited for limited transmutation:
- The role of thermal reactors for transmutation in the US is strongly reduced by the policy that avoids separation of pure plutonium, and the lack of a specific US infrastructure

- Fast reactors can effectively destroy all transuranics
  - Proliferation issue
  - Waste issue
- GNEP-TD will focus research on fast reactor recycling

Major Remaining Challenges for Fast Reactors

- Cost reduction
  - Future deployment
- Demonstration of passive safety
  - R&D and demonstration program
- TRU fuels
  - The major issue for transmutation
- Associated separations processes
  - Coupled decision
  - Metal/pyro or another combination

SUMMARY

- GNEP is a redefinition of this country's nuclear energy strategy
  - Set the agenda for years ahead
- GNEP-TD is the domestic demonstration program to support GNEP goals
- FY06 is the stand-up phase for GNEP and GNEP-TD
- Technology development geared to Summer 08 Secretarial decision
- Discussions have taken place with a number of countries on cooperation